PREVALENCE OF ELECTROLYTE IMBALANCE IN PATIENTS WITH TYPE-2 DM: A CASE CONTROL STUDY

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ABSTRACT-
Introduction- Diabetic patients frequently develop different types of electrolyte disorders. They are due to insulin deficiency or resistance manifesting as hyperglycaemia and, if not corrected, will lead to serious consequences-

Aim- Comparison of serum electrolytes [(Sodium (Na^+), Potassium (K^+) and Chloride (Cl^-)] between healthy controls and patients with type 2 diabetes mellitus.

Methodology- Case Control study conducted at department of Biochemistry SMS Medical College, Dhanwantri OPD block, SMS Hospital, Jaipur on 120 subjects who were divided into two groups- group I (Controls) (n=60): Healthy individuals without a history of any disease (non - diabetic) and group II (Cases) (diabetic) (n = 60): Confirmed cases of type 2 diabetes mellitus on oral hypoglycemic drug.

Results-. In present study mean serum sodium level and mean serum chloride level in case group and control group was comparable (p>0.05), whereas mean serum potassium level in case group was significantly higher than control group (p<0.001). The mean sodium level had not significant correlation with HBA1C but mean serum potassium showed strong positive correlation with HbA1C levels (p<0.001) i.e. as HBA1C rises potassium become more deranged significantly.
Conclusion- Present study demonstrated the importance of measuring serum electrolytes in patients with type 2 diabetes mellitus.
Keywords- hyperglycaemia, serum electrolytes.

Introduction- The plasma concentration of sodium is in the range of 135 - 145 mEq / L. Sodium contributes to the acid-base balance as sodium bicarbonate. The sodium-potassium pump is essential for the maintenance of cell membrane potential. Sodium transport is coupled to the transport of potassium, glucose, galactose, or amino acids. This belongs to the type of secondary active transport. This mechanism is responsible for absorbing glucose, galactose and amino acids from the proximal jejunum and reabsorption of these molecules from the proximal renal tubules. Potassium is a major cation of intracellular fluid. Total body potassium is about 3600 mEq. About 95 % is in cellular water. The plasma concentration of potassium is in the range of 3.5 to 5.0 mEq / L [1].

In clinical practice, electrolyte imbalances are frequently seen. They mostly affect hospital populations, affecting a wide range of patients (from asymptomatic to severely sick), and are linked to higher rates of morbidity and mortality. In community subjects, electrolyte homeostasis disruptions are also commonly reported. Even modest and persistent community-acquired electrolyte abnormalities are associated with a poor prognosis. Electrolyte imbalances are typically complex in nature. Numerous pathophysiological factors, either alone or in combination, are important. These include dietary condition, gastrointestinal absorption capacity, coexisting acid-base imbalances, pharmaceutical drugs, other concomitant disorders (mostly renal disease), and acute illness [2-4].

Diabetes mellitus (DM) is included among the diseases with increased frequency of electrolyte abnormalities given that the aforementioned factors (especially impaired renal function, malabsorption syndromes, acid-base disorders and multidrug regimens) are often present in diabetics[5]. Diabetic patients frequently develop different types of subclinical electrolyte disorders. They are due to insulin deficiency or resistance manifesting as hyperglycaemia and, if not corrected, will lead to hyperketonaemia. The most frequently seen electrolyte abnormality in DM in clinical practice is hyponatremia, which is associated with increased morbidity and mortality. However, potassium, chloride, calcium and magnesium disturbances are not uncommon.[6] Potassium becomes a crucial marker in diabetic nephropathy. It is monitored in diabetic nephropathy cases as one of the markers in evaluating end-stage renal disease and planning of dialysis.[7] The present study aimed to evaluate the electrolyte imbalance in type 2 diabetes mellitus.

Aim- Comparison of serum electrolytes [(Sodium (Na^+), Potassium (K^+) and Chloride (Cl^-)] between healthy controls and patients with type 2 diabetes mellitus.

Methodology- Case Control study conducted at department of Biochemistry SMS Medical College, Dhanwantri OPD block, SMS Hospital, Jaipur from September 2023 to July 2024 on 120 subjects who were divided into two groups- group I (Controls) (n=60): Healthy individuals without a history of any disease (non - diabetic) and group II (Cases) (diabetic) (n = 60): Confirmed cases of type 2 diabetes mellitus on oral hypoglycemic drug.

Results-

Table-1 : Age distribution of Study Subjects

Age group (years)	Case		Control		Total		P value
	N	%	N	%	N	%	
20-39	10	16.67	10	16.67	20	16.67	

40-59	32	53.33	32	53.33	64	53.33	1.000
60-79	18	30.00	18	30.00	36	30.00	
Total	60	100	60	100	120	100	
Mean ± SD	51.48 ± 11.86		50.03 ± 19.41				

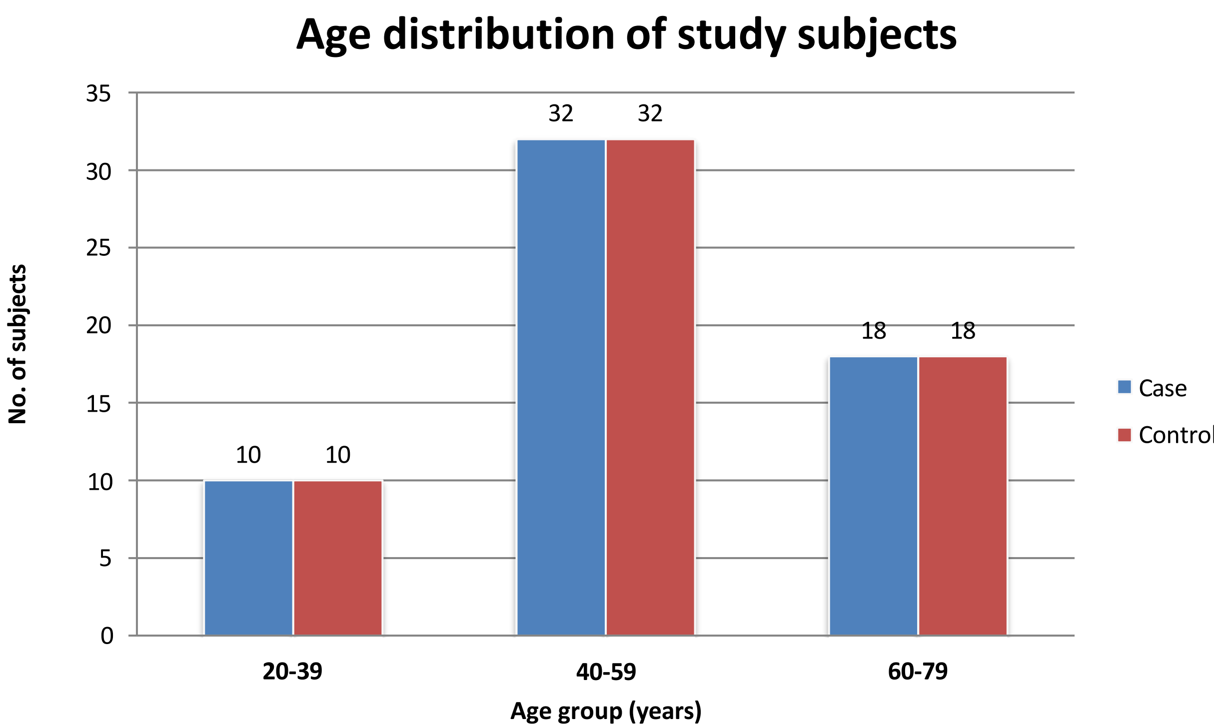


Table-2: Sex distribution of Study Subjects

Gender	Case		Control		Total		P value
	N	%	N	%	N	%	
Female	29	48.33	25	41.67	54	45.00	0.582
Male	31	51.67	35	58.33	66	55.00	
Total	60	100	60	100	120	100	

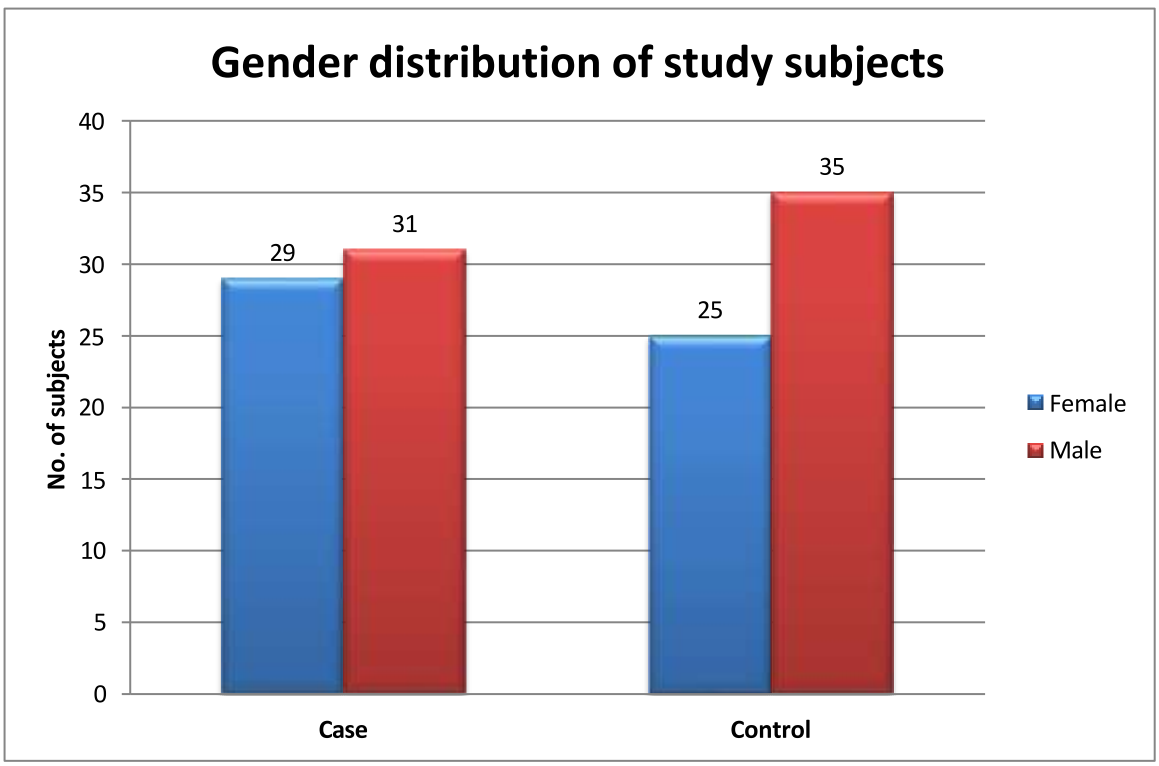


Table-3: Mean Serum Sodium of Study Subjects

Group	N	Mean SD	P value
Case	60	138.36 ± 2.83	0.060
Control	60	139.39 ± 3.10	

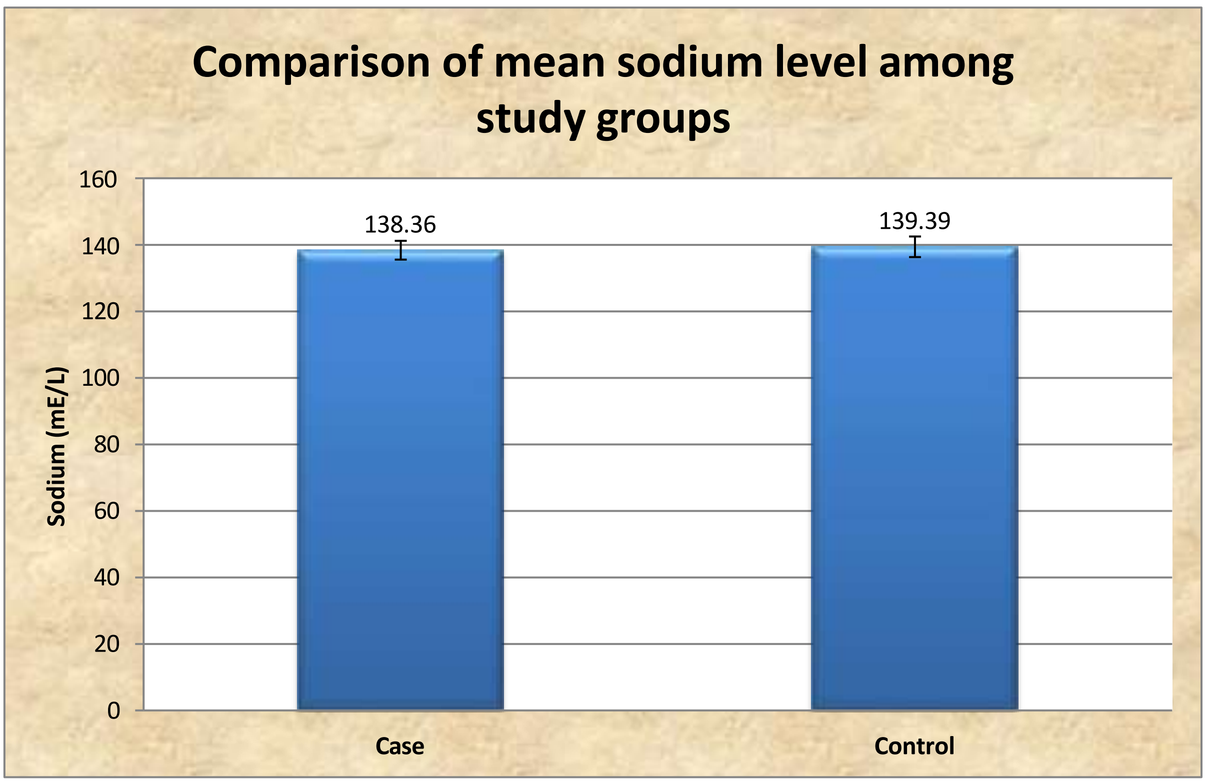


Table-4: Mean Serum Potassium of Study Subjects

Group	N	Mean SD	P value
Case	60	4.60 ± 0.43	<0.001 (S)
Control	60	3.81 ± 0.44	

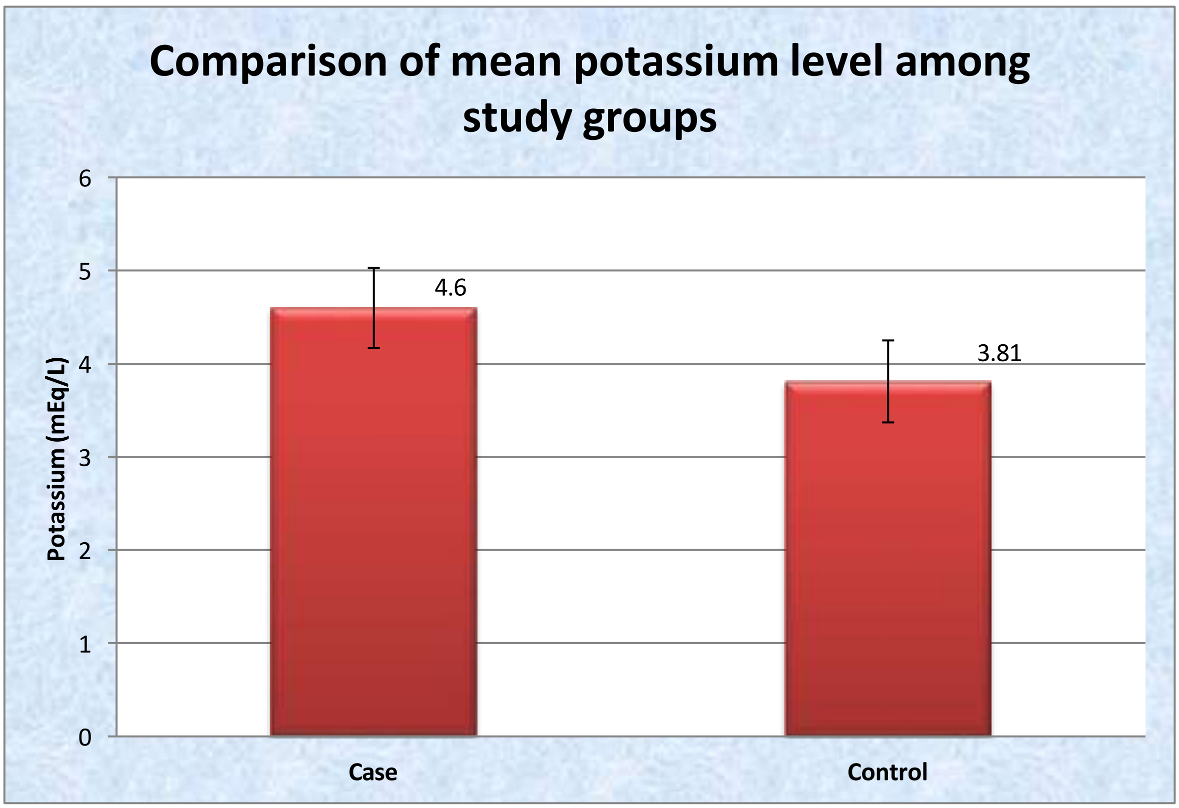


Table-5: Mean Serum Chloride of Study Subjects

Group	N	Mean SD	P value
Case	60	100.61 ± 4.06	0.061
Control	60	99.3 ± 3.48	

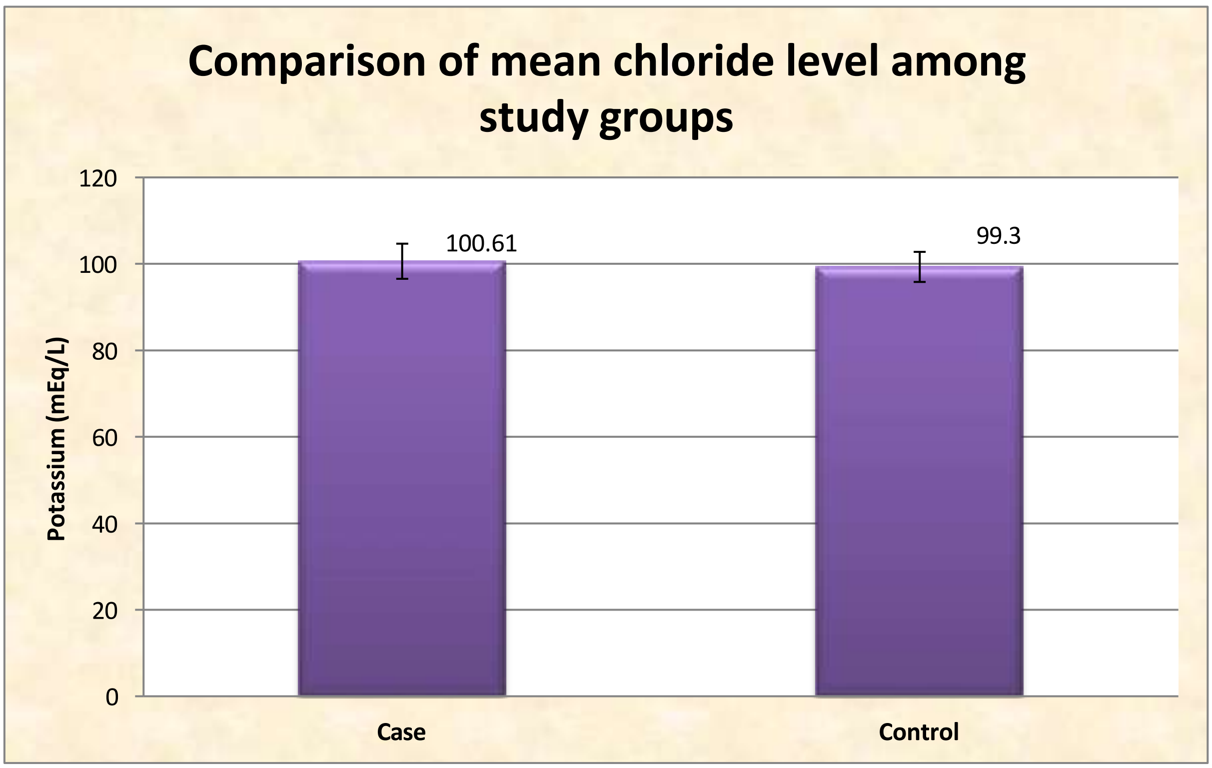
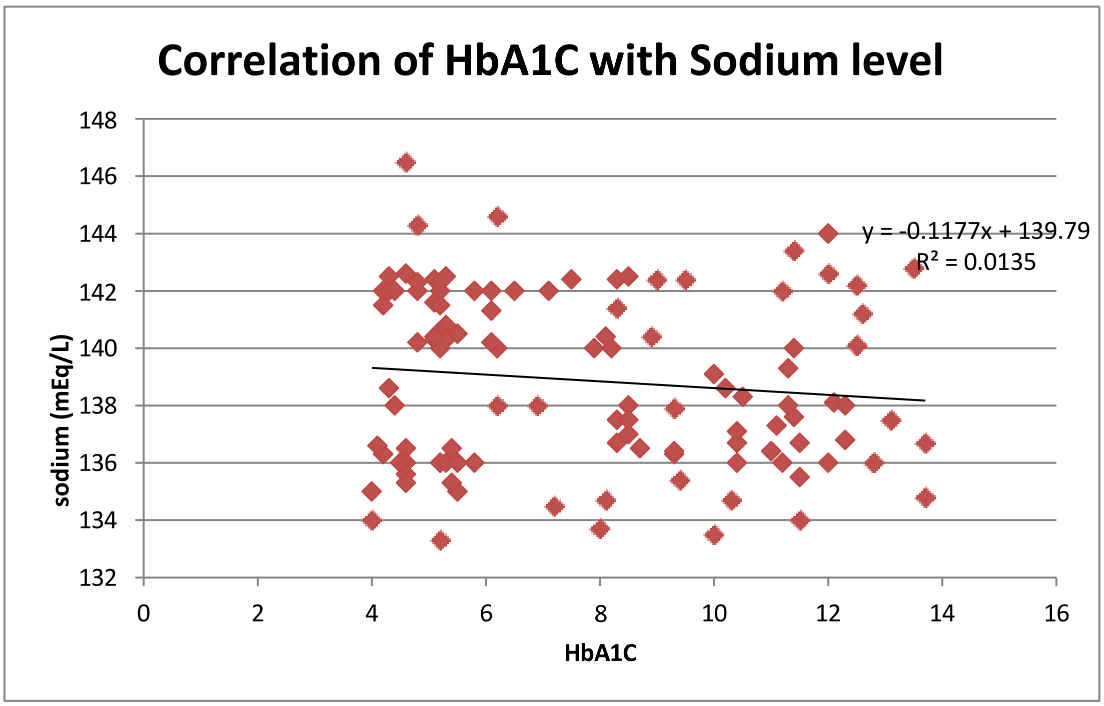
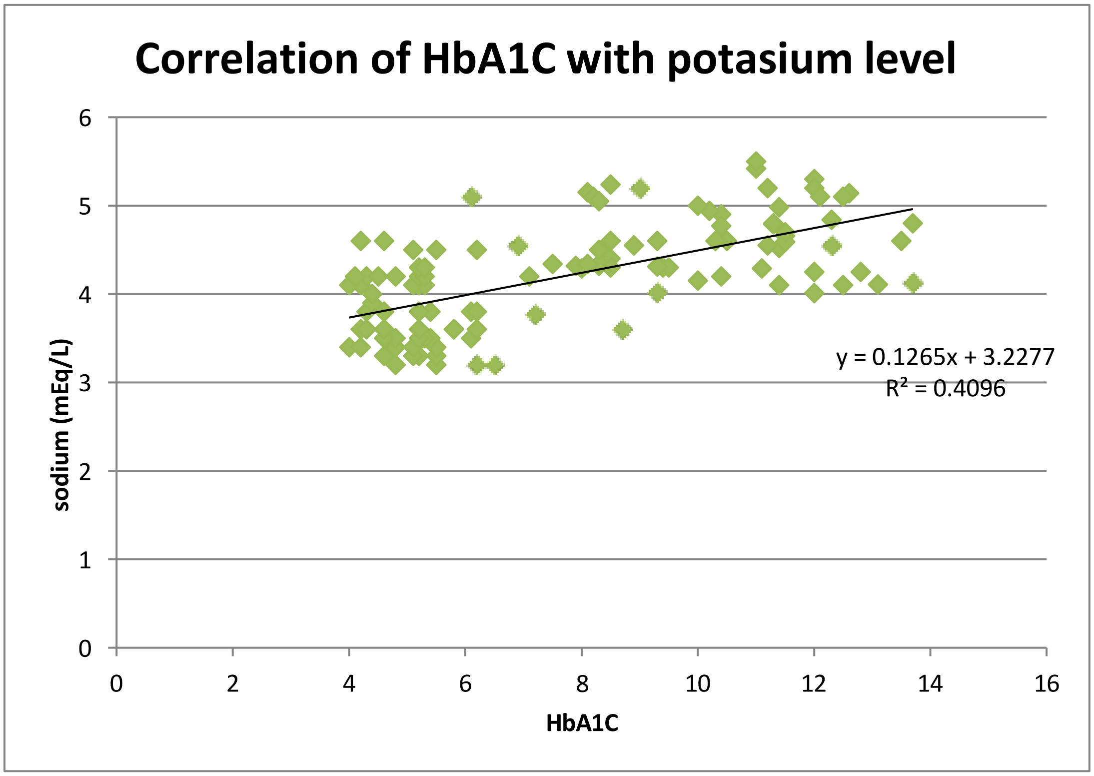
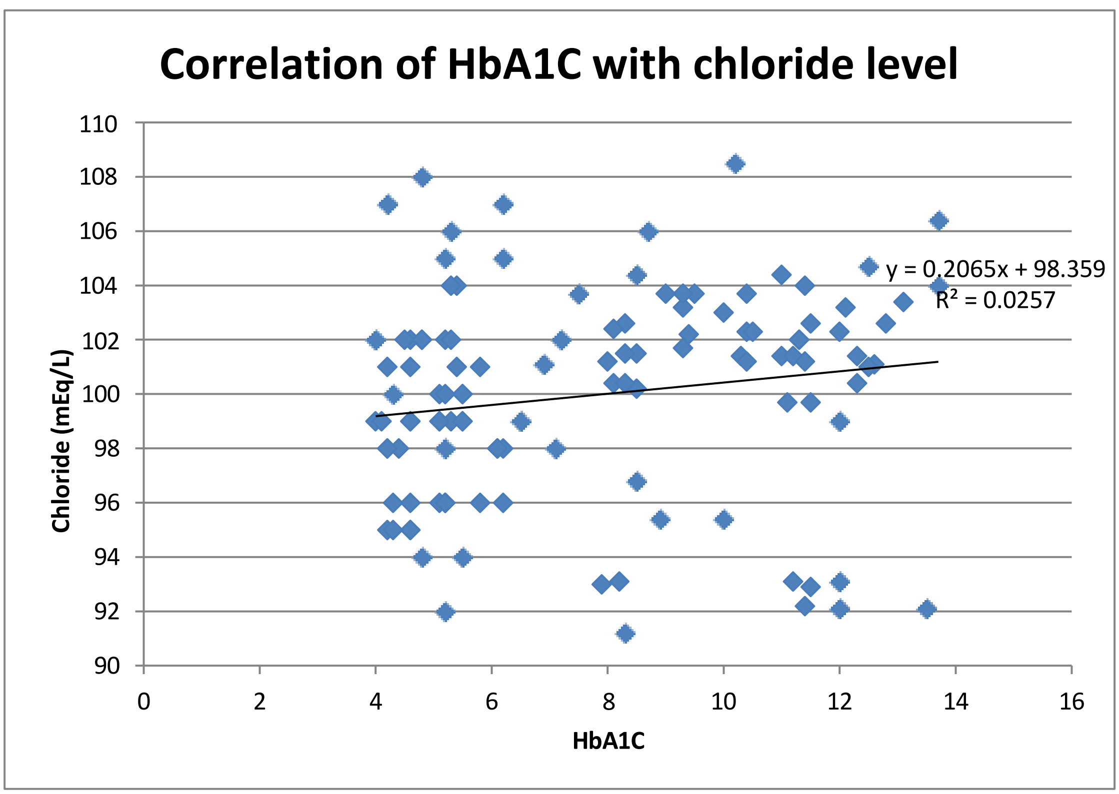


Table-6: Correlation of HbA1C with Serum electrolytes

Serum electrolytes	Correlation coefficient (r)	P value
Sodium	-0.16	0.207
Potassium	0.64	**<0.001 (S)**
Chloride	0.161	0.080




Correlation of HbA1C with potasium level
sodium (mEq/L)
HbA1C
y = 0.1265x + 3.2277
R² = 0.4096
0
1
2
3
4
5
6
0
2
4
6
8
10
12
14
16


Correlation of HbA1C with chloride level
Chloride (mEq/L)
HbA1C
y = 0.2065x + 98.359
R² = 0.0257
90
92
94
96
98
100
102
104
106
108
110
0
2
4
6
8
10
12
14
16

Discussion- The association between blood glucose and serum electrolytes is multi factorial in which it is related to a number of other factors, which includes age and associated conditions. Increased urination leads to loss of electrolytes and water and results in the imbalance which disturbs sodium and potassium levels in the body. Studies suggest that uncontrolled DM can also induce hypovolemic hyponatremia due to osmotic diuresis. Furthermore in diabetic ketoacidosis, urinary electrolyte loss magnify the renal sodium wasting .[8]

In the present study it was found that sodium levels in diabetes patients was found to be high when compared with controls and sodium was correlated negatively with glucose and it was found to be statistically significant. Increased or normal plasma sodium concentrations in the presence of hyperglycemia indicate a clinically significant deficit in total body water. Poorly controlled DM was implicated in the development of hypernatremia in few cases. Consequently, in patients with uncontrolled DM, serum concentration of [Na+] is variable, reflecting the balance between the hyperglycemia-induced water movement out of the cells that lowers [Na+], and the glucosuria-induced osmotic diuresis, which tends to raise [Na+][9].

In present study mean serum sodium level was lower in Diabetic group as compared to control healthy group but the difference was not statistically significant. Rajagambeeram R et al.(2020) [10] in their study found that study mean serum sodium level was lower in Diabetic group as compared to control healthy group but the difference was not statistically significant which is consistent with results of present study. However Das A et al [11] Ahmed R et al [12] and Bruktawit Eshetu et al [13] in their study found that mean serum sodium level was significantly lower in Diabetic group as compared to control healthy group incompatible with results of present study. The inconsistency between various studies could be due to differences in sample size and difference in risk factors which leads to hyponatremia in Diabetic patients.

The most typical electrolyte disturbance in clinical setup is hyponatraemia leading to morbidity and mortality. Na + / k + -ATPase is a ubiquitous enzyme that ensures Na + and k + gradients' equilibrium across the cell membrane and maintains by transporting 3 Na + out and 2k + into the cell. Alterations to this transport system are linked to several complications in diabetes mellitus disorders. It is proposed that the correlation between diabetes mellitus and decreased serum sodium may be due to the altered vasopressin regulation. Insulin stimulates the expression of vasopressin-induced aquaporin AQP-2 water channels. The absorption of water in the intestinal tract is increased due to slower stomach emptying that may play a role in hyponatraemia[14]. Hyperglycemia leads to an increase in serum osmolality, which results in water movement to the extra cellular compartment, out of the cells, and reduces serum sodium levels by dilution. Hyperglycemic status also induces hypovolemic-hyponatremia due to osmotic diuresis [15].

In present study mean serum potassium level was higher in Diabetic group as compared to control healthy group and the difference was statistically significant. Similarly Datchanamurthi S et al[16], Thivyah Praba AG et al[17], Rajagambeeeran R et al[10], and Bruktawit Eshetu et al[13] in their study found that mean serum sodium level was significantly lower in Diabetic group as compared to control healthy group which is inconsistent with results of present study.

The association of blood glucose and serum electrolytes is multifactorial and is related to several other factors, including age and other associated conditions leading to electrolyte disturbances. The increase in urination results in loss of electrolytes, water and other metabolites and results in imbalance. This disturbs sodium and potassium levels in the body. Exogenous insulin also can induce mild hyperkalemia as it promotes the potassium influx into the hepatic cells and skeletal muscle cells, thereby increasing the activity of Na+ and K+ ATPase pump. Also, hyperkalemia is associated with impaired insulin secretion, leading to decreased glucose utilization in the peripheral tissues. This results in carbohydrate intolerance and hyperglycemia [18].

In present study mean serum chloride level was higher in Diabetic group as compared to control healthy group but the difference was not statistically significant. Rajagambeeram R et al[10] in their study found that mean serum chloride level was higher in Diabetic group as compared to control healthy group but the difference was not statistically significant which is consistent with results of present study. However Das A et al [11], Ahmed R et al[12] and Bruktawit Eshetu et al[13] in their study found that mean serum chloride level was significantly higher in Diabetic group as compared to control healthy group which is inconsistent with results of present study. The inconsistency between various studies could be due to differences in sample size and difference in risk factors which leads to hyperchloremia in Diabetic patients.

Elevated chloride levels were detected in patients of diabetes, which might be due to the effect of diabetic ketosis. Ketoacidosis may reduce the pH of blood, which disturbs the acid-base balance leading to elevation of chloride levels [19].

The present study shows that high HBA1C i.e. poorly controlled glycemic control was significantly associated with electrolyte imbalance of potassium but present study did not shows that high HBA1C i.e. poorly controlled glycemic control was significantly associated with electrolyte imbalance of sodium and chloride level. Al-Rubeaan K et al [19] in their study found that serum potassium abnormality in DM patients was significantly correlated with HBA1C level and reported a increasing pattern in serum potassium levels with raised HBA1C which is consistent with results of present study. However Parmar SK et al[20] reported a decreasing pattern in serum potassium levels with raised HBA1C which is inconsistent with results of present study.

Limitations-This investigation was done on a sample of modest size in a single center; therefore, the effects of modest sample size should be considered while generalizing the results.

Conclusion-Present study demonstrated the importance of measuring serum electrolytes in patients with type 2 diabetes mellitus. As HBA1C rises, electrolytes mainly potassium become more deranged significantly. Therefore measuring serum electrolytes in type 2 diabetes patients should be done as part of routine patient care. The present study showed hyponatraemia and hyperkalaemia with increased hyperglycemia i.e. there is inverse relation between serum Na+ and K+ levels and it is dependent plasma glucose level. Taking in consideration of the multifactorial origin of hyponatraemia and hyperkalaemia, a cause-specific treatment is required to avoid any risk.

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